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Situation and perspectives of waste biomass application as energy source in Serbia

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ABSTRACT

The Autonomous Province of Vojvodina is an autonomous province in the Republic of Serbia. It is located in the northern part of the country, in the Pannonia plain. Vojvodina is an energy-deficient province. The average yearly quantity of the cellulose wastes in Vojvodina amounts to about 9 millions tons barely in the agriculture, and the same potential on the level of Serbia is estimated to almost 13 million tons. Only minor part of straw is utilized, and almost two-thirds are incinerated on fields owing to the problems during plowing under. The large sector in Serbia utilizes only about 15% of straw, while the individual one utilizes about 50% of straw and 20% of cornstalks. Environment pollutions, abandonment of the utilization of at least of one-third of the yield and extermination of the natural resources, primarily of humus, represent very adverse results of such procedures. Main problems with respect to the profitable usage of straw and other post-harvest residues are high expenses of their collection (collecting, balling or some other manner of compression), transportation from production- to the usage cites, as well as their handling and storaging. The agricultural production in Serbia should be based on the system of farms. For the efficient farming, it is obvious to organize life of producer and of his family immediately close to the production capacities. For the agriculture development, it is obvious to create a system of premiums, efficient crediting and the elaborated tax system that could create a basis for the certitude of work, confidence and constant growth of production, together with the mentioned and other measures. As the result of the activities oriented to substitution of the classical energents with energy obtained from biomass, farm that is in a higher degree energetically independent should be created. In such case, farms should apply the basic principles of the cleaner manufacturing, as an integral part of the concept of the sustainable development.

Contents

1. Introduction

The Autonomous Province of Vojvodina is an autonomous province in the Republic of Serbia, with about 27% of its total

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population according to the 2002 Census. It is located in the northern part of the country, in the Pannonia plain. Vojvodina is an energy-deficient province.

Because the energy, irrespective in which form, represent basis for human activities, the increased needs and consumption of energy is always present. On the other hand, actual structure of the primary energy resources cannot assure such a tendency on the global level. The limited reserves of fossil fuels, especially of the crude oil, whose reserves are estimated to last for a period of 30–40 years, instigate the humanity to turn itself to search for supplements of oil and of its derivatives. With the global energy crisis, global ecological problems are intimately related. That fact is that the existing period of the depletion of the existing oil reserves would be decreased to less than 10 years, if the whole mankind of the Earth would increase its energy consumption to the level that exist in countries of the developed World. Natural energy reserves on the Earth are considered to be practically inexhaustible, but the existing technological basis uses these resources in an extremely irrational manner. The application of these abundances of energy is stipulated with the directions of development of technology and economy. This is especially evident that in Serbia, as well in the World, the always accessible, and today drastically ignored, huge quantities of energy could be obtained by the conversion of organics. Only the plant that grow on the Earth contains more than 18,000 billion of tons of the dry substance, whose energetic equivalent amounts to 30×10^{21} J. Yearly production of the plant biomass owing to the photosynthesis amounts to 173 billion of tons of the dry substance. The European Union prescribed that by the end of the year 2010, participation of biomass in the commercial energy has to be increased from the programmed 6% to 12%. Applying this program, some countries in Europe yet use some 20% of their commercial energy obtained from the biomass (Austria, Sweden, Finland), and in the underdeveloped countries this figure reaches up to 5% [1].

The increase of energy consumption rate in Serbia is relatively high (6–7% yearly) and with the reserves of the primary energy it is about six times poorer than the World's average. The use of biomass in Serbia is significant not only with respect of the momentary solution of the energy deficiency problem, but, even more, with respect to unavoidable depletion of the fossil fuels and the ever increasing problem of the global warming owing to the CO_2 emission. The additional weight for considerations of the renewable energy sources generally, and especially in the case of Serbia, makes the process of adaptation and of preparing of Serbia for the inclusion into the European Union.

The general concept of the biomass is very wide and it includes the biomass of plant and of animal origin. However, according to the estimations, of the total quantity of biomass produced in the World, less than 4% is utilized. Approximately 1.2% of that quantity is used for food and feel, some 1% for pulp an paper production and only about 1% for the energetic purposes, that is, for fuel. Unfortunately, the energetic application of biomass is mainly limited on wood as a fuel for direct combustion, what in the majority of cases is not ecologically justifiable and what cannot be considered as a basis for further increase of application of biomass [2].

2. Waste biomass

Waste biomass, that is considered as a potential energy source, can be divided on biomass originated in the forestry and the biomass generated in the agriculture. The waste biomass, generated in the agriculture, can further be divided according to the agriculture branches on biomasses from field crops cultivation, or from orchards and vineyards, and that from the livestock cultivation. In spite to the fact that this very last waste represents waste directly originated by the animals, owing to the fact that it contains organic substances that basically are of the plant origin, it is considered to be the biomass. The field crops cultivation biomass is the largest potentionaly available biomass and it is contained in the residues obtained during the primary harvesting of the field products [2].

The primary advantage of the waste biomass as an energy source represents not its huge potential, because it is only to the limited degree usable, but in its renewable nature. Its renewable characteristic is a reason for its preference with respect to the classical, fossil fuels that must be, in the relevant period, be considered as non-renewable, and, as such, could not represent the basis of the sustainable development, which includes the rational energy consumption as well.

The average yearly obtained of the (lygno) cellulosic wastes in Vojvodina make some 9 million tons only in the agriculture, and the same potential for Serbia is estimated to be just something less than 13 million of tons. Only small part of straws is utilized, and about two-thirds are combusted on the allotments, due to the problems connected with their plowing under. The accustomed combustion of the post-harvest residues means not only wastes of the organic substances and of considerable energetic value contained in it, but also the destroyment of humus and annihilation of microorganisms from the surface layer of soils. Besides to that, the combustion of the post-harvest residues lifers not only carbon into the atmosphere, but also the other significant biogenic elements, such as nitrogen and phosphorus. As the combustion residue remains only ash, containing only mineral substances, which, by the greater part, are less acceptable to the plants. Very inconvenient is also the fact that, during the combustion of the post-harvest residues, the best combustion properties have the most valuable parts of plants, i.e. the leaves, having more convenient chemical composition, and the stalks incinerate harder. The combustion of the post-harvest residues need the significant quantities of oxygen and at the same time, contaminates the environment with smoke and ash, and annihilates, besides to the harmful, also the useful animals. Combined with the intensive exploitation of the agricultural soils and minimal utilization of organic fertilizers, all these factors permanently degrade the agricultural soil. Besides, the other unacceptable consequences appear as well. In spite to the abundance of the harmful consequences, the incineration of the post-harvest residues on parcels where they were originated represents often-found appearance. Under the conditions of the inadequately developed livestock cultivation in the agriculture of our country, the agricultural wastes find not their application on the field crops cultivation, so that they represent the worthless ballast. The crucial significance for this phenomenon has also the fact that, for the successful ploughing under of the post-harvest residues, such as corn stalks or the sunflower stems, the appropriate mechanization is needed, whose utilization necessitates definite spending of human work and funding. In order of the avoiding of such spending and problems, the simplest, and at the same time ecologically, on the long term economically the most inconvenient solutions, in the form of incineration on parcels, is applied. To this harmful practice contributes also the fact that, together with combustion of the post-harvest residues, some benefits owing to the annihilation of weeds and pests are achieved, what contributes to the easier primary cultivation of soils.

Because of that, the significance investigation of the possibilities of the energetic uses of the post-harvest residues is more than the simple technological progress, as it represents the alternative way that the undeveloped countries have to choose. In order of enabling the chose of the right orientation of such one development, it is unavoidable a priori to create the technical and

Table 1
Ratios between grain yields and post-harvest residues for the definite field crops cultivation cultures in Vojvodina.

Field crops culture	Ratio grain/post-harvest residues
Wheat	1:1
Corn	1:1
Soybean	1:2
Sunflower	1:2
Barley	1:1
Oats	1:1
Rye	1:1,2

technological, as well as the economical basis for the development, estimation and application of the alternative technologies [3,4].

3. The available quantities of the post-harvest residues in Serbia

The estimation of the total potentials of the post-harvest residues, i.e. the waste biomass from field crops cultivation, can be obtained by the application of yield of the basic field cultures. The relations between the quantities of basic products and the by-products are shown in Table 1. The data showed in Table 1 are used for the analysis of the available waste biomass from the field crops cultivation.

Based on the grain yields of the specified cultures and the coefficients meaning the quantity relations between the grain yields and the post-harvest residues, the yield of the waste biomass, i.e. the yield of the post-harvest residues can be calculated. The potential sources of waste biomass, i.e. of post-harvest residues, which, up to today were not used adequately, were analyzed as the possible raw materials + for energy production. The quantities of field crops cultivation residues were separately discussed for the region of Serbia, for the region of Serbia without Vojvodina, and for the region of Vojvodina, for the last 20 years. Such one analysis is very significant in the light of the existing differences that exist in the agricultural production between the mentioned regions.

Table 2
Average quantities of the post-harvest residues from the main field crops cultivation in Serbia and in Vojvodina during the last 20 years (metric tons/year).

Field crops culture	Totally	Serbia without Vojvodina	Vojvodina
Wheat	2,465,870	1,038,428	1,427,442
Corn	5,198,999	2,112,961	3,086,039
Soybean	191,969	13,984	177,985
Sunflower	747,477	61,506	685,972
Barley	278,747	114,778	163,970
Oats	109,543	93,016	16,528
Rye	12,078	9,750	2,328
Totally	9,004,685	3,444,422	5,560,263

Table 3
Structure of the average yearly quantities of the post-harvest residues in Serbia and in Vojvodina during the last 20 years (%).

Field crops culture	Totally	Serbia without Vojvodina	Vojvodina
Wheat	27.38	30.15	25.67
Corn	57.74	61.34	55.50
Soybean	2.13	0.41	3.20
Sunflower	8.30	1.79	12.34
Barley	3.10	3.33	2.95
Oats	1.22	2.70	0.30
Rye	0.13	0.28	0.04
Totally	100.00	100.00	100.00

During the last 20 years the tendencies of decreasing of the field crop cultivation residues in Serbia is evident, amounting in average to about 0.6% yearly. This trend is much more expressed in Vojvodina, being 0.67%, while in Serbia the average decrease of the mentioned field crop cultures is 0.47% yearly. Tendency of decreasing of field crops production in Serbia could be partially accounted to the decreasing of shares of the analyzed cultures, and, on the other hand, to general decreasing of agricultural production after 1990, as a consequence of the economic crisis during 90s and other economical factors.

Tables 2 and 3 show the average quantities of the post-harvest residues in Serbia and in Vojvodina, i.e. the quantities of by of field crops production, for the distinctive cultures. It is evident that the largest part of the post-harvest residues generates corn- and wheat productions, what is the consequence of the fact that these two cultures are the most prevalent ones in the field crops growing in Serbia. Besides to the named two cultures, sunflower share amounts to above 10%, barley and soybean shares are just above 5%, while shares of oats and rye can be considered as figurative ones. Shares of the distinctive cultures in general structure of planting can be considered as a good indicator for the development of new technologies of collection of the post-harvest residues and biomass production.

4. Possibilities for the energetic exploitation of the waste biomass

Biomass as the agricultural by-product is the traditional and renewable source of feed and a raw material for the obtaining of energy. The use of biomass as an energy source represents not the novel technology, but in the most cases biomass collection, transportation and storaging methods were extensive, so that they a considered to be economically and organizationally not sustainable in the modern environment. Such methods of application of the post-harvest residues are possible only in the cases of the latent no employment in the extensive farming. Impossibility of neglecting of high potential of this resource and its renewability push the people to search for solutions, which could possibly assure economically sustainable exploitation of this resource. At the time, biomass in the World has not the significant share in the energy consumption. High grow of consumption in the last decade shows the gas, with 15%, followed by oil with 13.1%. At the same time, coal consumption decreased for 5.3%. The growth of consumption of the hydro-energy was 22.8%, of nuclear energy 25.7%, and that of other forms of primary energy, including the biomass, amounted to 68.1%. Though the consumption of these form of primary energy showed the highest increase, their share in the total energy consumption remained very modest, only about 1.3%. The highest shares still have liquid fuels (39.8%), followed by coal (23.2%) and natural gas (22.4%). Shares of the hydro- and nuclear energies were 7% and 6.4% respectively.

Agricultural by-products are increasingly considered as the significant raw matter potential and they acquire more and more significance in the industrial production. At the time, they are not adequately used in Serbia, although they exist approximately in similar quantitie4 s as the primary products, with respect to cereals, and even more with respect to the other crops. Corn, besides to the corn stalk, as the by-product lifers corncobs as well. Basically, great influence on the available quantities of the post-harvest residues expresses the manner of their collection. The average yearly quantity of cellulosic wastes in Vojvodina shows Table 4.

The large agricultural enterprises in Serbia utilize only about 15% of straws, while individual enterprises utilize some 50% of straws and 20% of corn stalks. In the majority of cases, post-harvest residues are burned on the fields. Environment pollution,

Table 4
Average quantities of cellulosic wastes in Vojvodina (tons/year).

Waste	Quantity
Corn stalks	4,140,000
Corn cobs	910,000
Cereal straws	1,870,000
Sunflower and broomcorn stalks	600,000
Wood wastes from forrestry	90,000
Wood wastes from processing	180,000
Orchard- and vineyard wastes	110,000
Canes and cones	100,000
Totally	8,000,000

abandonment of the utilization of at least one-third of yield and destroyment of natural resources, primarily of humus, are very poor results of such procedures.

In the near future, before the application of biomass for better purposes, it can represent energetic potential that should not be neglected when considering potential energy sources. As the basic energetic usage of the post-harvest residues, firstly are considered their energetic conversions by the combustion, and then their usage as the raw materials for ethanol production [5].

Energetic value of the post-harvest residues is defined for their standard moisture content, which is in the limits between 10% for straw, to up to 25% for corn stalks. In the cited cases, their energetic values are 14,000 and 18,000 kJ/kg, what is similar to the wood. The most important physical properties of the waste biomass with their possible limits are shown in Table 5.

Characteristics of biomass, i.e. kinds of biomasses that can be applied for the energetic exploitation, are not uniform. However, if the by-products obtained in field crops cultivation are analyzed, this statement can be neglected (Table 6) while, observed at the standard moisture levels, the post-harvest residues have relatively uniform properties. The stated data refer to the ideal conditions, when the moisture contents of the post-harvest residues reach minimal values. Under the conditions of the real exploitation, these values are, by the rule, lower.

Because the agricultural production is performed under the direct influence of the climatic factors, moisture content in the prepared biomass varies considerably. As the consequence, post-harvest residues may be made partially or totally unusable for the energy production. Opposite to coal, post-harvest residues practically contain not sulphur and contain very low quantities of ash (2–8%). Being aware of the existence of threats of the ecological catastrophe and of global changes of climate on the Earth, this fact is quite significant. From the point of view of global climate changes, the largest problem represent enormous emissions of carbon dioxide, and than those of sulphurous oxides, created during the combustion of fossil fuels. Total ecological advantages of this usage of the post-harvest residues ought primarily to include preservation of the soil fertility, followed by preserving of cleanness of the atmosphere.

Table 5
The most important physical properties of waste biomass.

Physical properties	Value
Heat content, MJ/kg	5–10
Density, mg/m^3	400–900
Bulk density, kg/m^3	40–600
Heat content, MJ/m^3	0.7–12
Moisture contentm %	8–50
Ash contentm %	1–10
Volatile combustible substances content, %	50–70
Ash sintering temperature, °C	650–800

Table 6
Energetic values of the post-harvest residues.

Types of the post-harvest residues	Energetic values (MJ/kg)
Straws from stubble cereals	16.2
Corn stalks	17.1
Soybean straw	18.2
Hamp stalk	15.7
Sunflower husks	17.6

5. Energetic conversion of the post-harvest residues

As the basic form of the energetic application off the post-harvest residues, in the World, as well as in Serbia, procedures of the energetic conversions are applied that be classified as those based on direct combustion of the biomass as the solid fuel, and those including the gasification of the biomass (generator gas and pyrolysis) [6].

The performed analyses indicate to the fact that main problems for the economical application of straws and other post-harvest residues lie in the high costs of their collection (levying and balling or some other way of compression), transportation from place of their production to loci of consumption, as well as those of handling and of storaging. This problematic of costs primarily find its reasons in the dispersibility on large surfaces, low bulk weight of the post-harvest residues, as well as their unstable water contents.

The balled biomass can be used in the industrial fireboxes by the direct combustion or by the gasification procedure. The last procedure is developed because of general tendention of deficiencies of liquid and gaseous fuels, as well as because of the positive economic effects of production of thermal energy using this procedure. Knowing that this application, owing to the high transportation costs is spaciously limited, the economical application is usually limited to heating of rooms of agricultural administrations, heating of rooms for breeding of young livestock and similar purposes. In accordance with this, even higher and higher applications of biomass as the energy source are starting to appear [2].

The biomass in forms of straw, corncobs, sawdust and other wastes, grounded, compressed in the forms of granules or briquettes can to a high degree substitute liquid and gaseous fuels. In Serbia, as well in the technically developed countries in the World, efforts are undertaken for spreading-out of the biomass application as the substitute of fuels obtained from the oil derivatives. For those purposes the new furnaces for highest possible combustion of the biomass are constructed. However, for broader using of biomass as the energent in the individual furnaces (stoves in the households), the biomass has to be still more energetically concentrated, i.e. compressed and brought in the forms that are more convenient for transportation and handling. Owing to this, biomass must be converted in the form convenient for merchandizing. This is the goal of briquetting and pelletizing of biomass. At a time, in Vojvodina were constructed 48 plants for the direct combustion of wood residues, 79 plants for direct combustion of agricultural wastes and 13 plants for briquetting of the waste biomass. In spite to that, the realized substitution of oil with the biomass is still very low [1].

It is believed that the agricultural production in Serbia should be based on the system of farms. For the effective farm business it is necessary to organize life of farmer and his family immediately close to the production capacities. For the development it is necessary to create a system of awards, of the efficient credits and the elaborated tax system that, besides to the mentioned and other measures, would create a basis for the security of work, faith and

permanent growth of production. As the final results of the activities oriented to the substitution of the classical energents with energy obtained from biomass a farm is supposed to be born, which is in a high degree energetically independent. As the same time such farms would apply basic principles of cleaner production as a part of a concept of the sustainable development [7]. Besides, a possibility of utilization of the less productive areas for the growing of tree biomass, on the so-called timber farms, creates additive possibilities for the improvement of development of rural regions.

5.1. Direct combustion of the biomass

Direct biomass combustion is possible to realize with the use of the reconstructed energetic plants that use liquid fuels (heating oil and masut) and solid fuels, or by incineration in plants that use the biomass as the basic fuel.

It is thought that funding invested in these programs can be returned in a period of 2 or 3 years, and that the economics of the whole business of the users becomes increased. In such a way costs for fuel supplies are being minimized, as the supplies are obtained from the own waste raw materials. All this generates the economical, but also the technological security for the users. Considering the technological security of the users, it is primarily thought on the higher energetic self-adequacy of the technological processes that highly diminish risks of the total production. As the final step in the development of the combustion technology, it is possible to initiate the specialized biomass production exclusively for the needs of energy production.

5.2. Gasification of the biomass

Incomplete combustion of biofuel is the two-stage conversion of energy. In the first stage from biofuels is by the incomplete combustion (gasification) produced the mixed gas–biogas (where dominates carbon monoxide with some methane). After cooling and cleaning, biogas is possibly to apply for the very diverse purposes, such as power fuel for engines with internal combustion, heating of objects, and so on. Without purification, biogas can be directly applied for drying of the agricultural products. This technology of biogas production lifers a gas with calorific value of 4–7 MJ/Nm^3, with simple process technology, and up to 18 MJ/Nm^3 with the sophisticated technology that includes oxygenic gasification, but this process is rarely applied [6].

Gasification technique was actual already 50 years ago, when as fuels wood, coal corncobs were used. Today is this problem reaffirmed in the domain of investigation of energetic potentials of agriculture and as potential fuels are investigated: corn cobs, corn stalks, straws, sunflower stems, and so on.

5.3. Biogas production

Biogas is obtained in the process of anaerobic digestion due to activities of bacterial cultures that are present in manure. In the first phase, owing to the activities of saprophytic bacteria carbonaceous substances are converted into volatile acids and water, while in the second phase, acids are converted into methane and carbon dioxide. In this process quantity organic substances from solid wastes is diminished by 50–70%, and, besides the biogas, the digested manure is obtained, containing nitrogen, potassium and phosphorus. Any of organic substances, which represents source of necessary components in the process of biogas production, such as carbon, nitrogen, phosphorus, potassium, magnesium, etc., can be used as a raw material for biogas production. The most convenient for these purposes are the applications of community- and industrial wastewaters, human and animal excrements and the plant biomass. Most frequently, on the large farms adequate quantities of liquid manure and post-harvest residues can be found, so that they are mostly used as the raw materials for biogas production. As a fuel, biogas contains 70–75% of methane, so that its energetic value amounts to 20–25 MJ/Nm^3, corresponding to 0.7–0.8 kg of coal equivalents, of 0.6 Nm^3 of the natural gas.

With the application of digested manure as fertilizer, considerable quantities of mineral fertilizers can be saved, what is followed by the environment protection. In our country, daily more than 250,000 tons of manures are generated, making more than 42,000,000 tons of bio-wastes in the form of manures yearly. This manure is often a source of ecological hazards, i.e. of environment pollution. Namely, it is considered that, in a biological point of view, farm with 50,000 fatting swine contaminates the environment as it does a settlement with 250,000 inhabitants. This the very problem can be very productively solved by the bioprocessing of this waste, what enables production of approximately 4,000,000 Nm^3 of biogas per day, making 1,400,000 Nm^3 of biogas per year. This represents an equivalent of electrical energy as high as 3500 GWh/year. It is very significant that at the same time, some 25,000,000 tons of the digested manure, representing a substituent for mineral fertilizers, can be obtained.

Economy of the biogas production can be justified, by taking in account all tree effects of this process (energy production, digested manure production and environment protection). Changes in the approach and realization of concepts of energy production and consumption in Serbia are foreseeable, what is to a high degree dependent with the assurance of the necessary energy and the environment protection. In concordance to this, the technology of biogas production, which is momentarily considered to be uneconomical, yet, on the long term, has a perspective.

Problem of pollution is specially present in the intensive swine livestock cultivation that is performed on large farms, where the effects of pollution are concentrated and noticeable. Similarly, also the smaller less noticeable pollution created on smaller farms ought not to be neglected, but it, owing to its minor singular capacities and spacious dispersion, does not create significant problems, so that it at the time is not object of interest. However, cumulative effects of such one contamination surely in a longer period of time are evident.

In our conditions the biogas production should be oriented to the processing of swine manure, respecting that its biological value is low. At the moment, waste biomass from plant crops cultivation is not the most convenient raw material for the anaerobic digestion processes. Lygnocellulosic wastes, which represent the basic carbon sources in the production of biofuels, contain lignin, which is poorly fermented and degraded, creating difficulties in the decomposition of the cellulose as well. Because of that, these wastes have to be physically, chemically or physico-chemically pretreated, what creates the additional costs. Besides, plant crop wastes contain only small quantities of nitrogen, which is unavoidable for growth of microorganisms that take their part in the fermentation process. Because of that, these wastes have to be processed only as the mixtures with other substances, which contain high quantities of nitrogenous substances.

Wastewater from the food processing industry are treated with the anaerobic digestion process. Owing to their high contents of organic substances, their digestion is quite efficient, creating considerable quantities of gas. Special advantage of these wastewaters is in their high temperature, what makes the additional heating to the digestion process temperatures unnecessary. Their basic disadvantage is high sulphur-containing substances content, which, during the digestion, are transformed in the hydrogen sulphide.

Municipal wastewaters represent sources with low contents of elements that are necessary for biogas production. Owing to this,

they are not used as raw materials for biogas production. Share of energy obtained over biogas in the total energy balance of the country can be considerable. This increase could be obtained under the condition that as high as possible share of the available raw materials were processed. In the case of specific consumers, biogas production could cover greater part of their energetic needs, thus increasing their energetic undependability. If some parts of a plant should operate permanently, biogas production could be a complementary energy source. Besides to the obtained energy, owing to the use of the digested manure, mineral fertilizers could be saved, and the environment could be protected. Observations with economy of biogas production should be based on the application of differential calculations and tracing of the costs changes. Introduction of the economically effective biogas production creates the possibility of the improvement of the economic results in the sphere of swine livestock production. In such a way, it could be possible partially to diminish the uncertainties that nowadays characterize this sector.

5.4. Biodiesel production

While the technological process of biodiesel fuel is more or less well known, its economical analyses attracted much less attention. Historically, the idea of application of vegetable oils as the fuels appeared contemporarily with the beginnings of the more massive exploitation of fuels originated from mineral oil. Because of its biological origin and its similarity with mineral diesel, this fuel was commercially named as biodiesel. Biodiesel finds its application as fuel for municipal transport vehicles, for the work of agricultural machines, as well as for heating of rooms in the specific circumstances. In the European Union, appropriation for biodiesel production is concretized in the Directive 2003/30/EC. This directive foresees that by the end of the year 2010 alternative fuels (biofuels) should replace 5.75% of the conventional fuels.

For the evaluation of the economic parameters, starting parameters should be retail (purchase) prices of olaceous plants. Besides to the prices of the raw materials, as the rating of costs during processing of olaceous plants into crude oil, significant are other costs as well (cleaning of seeds, grounding of seeds, squeezing of oil, filtration and degumming). In the phase of reesterification, costs for different materials (methanol, sodium hydroxide, sulphuric acid, demineralized water and energy) should be included. Material costs are discounted for the values of the by-products. According to the existing investigations, plants with lower capacities do not realize satisfactory economic results.

Serbia has a considerable potential for the production of biodiesel. Biodiesel based on the inland's raw materials can be sold for the prices equivalent to the prices of the D2 fuel. However, for the vitalization of the biodiesel production, a plan of production and distribution of biodiesel should be defined and the construction of the distributive net should be stimulated, thus enabling the regular provision of biodiesel fuel. Besides to that, it is obvious to apply the corresponding measures of governmental stimulations (bonuses for the producers growing the olaceous plants, bonuses for the produced biodiesel fuel, introduction of the ecological taxes for the fossil energents), which are going to stimulate the biodiesel producers [2].

5.5. Bioethanol production

Ethanol could be produced by chemical synthesis, or by fermentation. Of the total ethanol production, more than 60% is produced by fermentation and its usual name is bioethanol. Ethanol can be obtained by syntheses from water and ethen in the presence of sulphuric acid as catalyzing agent. For production of bioethanol using fermentation, raw materials containing sugar, starch or cellulose could be used. While sugars and polysaccharides that can be used for bioethanol production represent constituents of many plants, a number of potentially possible raw materials for ethanol production is quite high. Raw materials containing sugars do not need costly pretreatment, while raw material containing starch or lygnocellulosic raw materials are cheaper, but they necessitate very costly pretreatment for conversion into form that is convenient for fermentation. Other raw materials, such as waste streams from different technological processes, have high potential, irrespectively that sugar contents in such streams are lower than those in the agricultural products.

Today, bioethanol production on Vojvodina is performed in six industrial plants with total annual production of about 22,000 tons. All these plants perform production of bioethanol with maximal ethanol content of 95% by volume, which is mainly used for strong alcoholic drinks, and to less degree for medical of pharmaceutical purposes. Bioethanol production in Vojvodina started significantly to decrease or to stagnate in the period of 1991 till 2000, after which, after the prolonged period of crisis, it started to recover and to increase. Production in 2005 was for almost 4% higher than in the precedent year. In spite to that, the realized production of bioethanol in Vojvodina in the year 2005 fulfilled not the domestic need, so that bioethanol imports were recorded [8–10].

6. Conclusion

Special attention in Serbia should be devoted to the technical solutions for energetic exploitation of biomass. In that case, accent should be on the technical solutions that would enable the biomass utilization with the existing or with modified equipment. Such solution could considerably diminish starting investments and have direct effect on the economy of the energy usage of biomass. The realization of these goals is possibly to achieve only with the stimulating measures of the corresponding governmental institutions. Government should stimulate the domestic industry on the orientation to production of equipment that is necessary for the energetic usage of biomass. The base of agricultural production, as well as of biomass usage in the production of energy should be a system of farms. For the efficient functioning of farms, it is necessary to organize life of producer and his family immediately close to the production capacities. For the development of the agriculture it is obvious to create a system of bonuses, efficient crediting, as well as the well-developed taxing system that, besides to the named and other measures, could make the base for security of business, confidence and permanent growth of production. As the final result of activities for substitution of classical energents with the energy obtained from biomass, a farm, which is to the high degree energetically independent, should be created. Such farms would apply the basic principles of cleaner production, as an intrinsic part of the concept of sustainable development. Besides, there exist a possibility of applying of the less productive soils for production of timber biomass in the so-called farms of wood, thus creating the additional possibilities for improvement of development or the rural environments.

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